

IN THE CLAIMS:

- 1 1. (Currently Amended) ~~An in-line~~ A method of fabricating a holographic mask for
2 ~~patterning a workpiece, formed by a process~~ comprising the steps of:
- 3 a) providing an illumination source for generating a coherent illumination
4 beam directed along an axis;
- 5 b) providing a non-opaque object mask ~~having a semi-transparent layer with~~
6 ~~an optical density between 0.1 and 5.0, said object mask~~ capable of
7 transmitting a portion of said illumination beam as undiffracted reference
8 wavefronts, and having one or more substantially transparent elements for
9 creating overlapping object wavefronts when said illumination beam is
10 incident thereon;
- 11 c) disposing said object mask in said illumination beam;
- 12 d) providing a holographic recording medium in said illumination beam
13 ~~adjacent~~ in line optically with said object mask;
- 14 e) illuminating said object mask with said illumination beam, thereby causing
15 said object mask to allow undiffracted reference wavefronts to pass
16 therethrough, and causing said one or more substantially transparent
17 elements to create object wavefronts which interact with said undiffracted
18 reference wavefronts to create an interference pattern ~~wherein said~~
19 ~~reference wavefronts and said object wavefronts have a beam ratio~~
20 ~~between 0.1:1 and 100:1; and~~
- 21 f) recording said interference pattern in said holographic recording medium

22 ~~so as to create a substantially continuous diffracting region over said~~
23 ~~holographic recording medium.~~

1 2. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 1, wherein said one or more substantially transparent elements
3 are selected from the group of substantially transparent elements consisting of
4 phase-altering, scattering, refracting, and diffracting.

1 3. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 1, wherein said step e) involves scanning said illumination
3 beam over said object mask during said recording of said interference pattern.

1 4. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim ~~1~~ 73, wherein said semi-transparent layer is chrome.

1 5. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 1, wherein said at least one or more substantially transparent
3 elements comprise an array of substantially transparent elements.

- 1 6. (Currently Amended) ~~An in-line~~ A method of fabricating a holographic mask
2 ~~capable of patterning a workpiece, formed by a process~~ comprising the steps of:
3
4 a) providing an illumination source for generating a coherent illumination
5 beam directed along an axis;
6
7 b) providing a substantially opaque object mask having one or more
8 substantially transparent elements for creating object wavefronts when
9 said illumination beam is incident thereon;
10
11 c) disposing said object mask in said illumination beam;
12
13 d) providing a holographic recording medium in said illumination beam
14 ~~adjacent~~ in line optically with said object mask;
15
16 e) illuminating said object mask with said illumination beam, thereby causing
17 said one or more substantially transparent elements to create object
18 wavefronts;
19
20 f) providing a reference beam that is coherent with said illumination beam
21 and has reference wavefronts that are in-line with said object wavefronts
22 and that interact with said object wavefronts so as to create an interference
23 pattern ~~and wherein said reference beam and said illumination beam have~~
24 ~~a beam ratio between 0.1:1 and 100:1; and~~
25
26 g) recording said interference pattern in said recording medium ~~so as to~~
27 ~~create a substantially continuous diffracting region over said holographic~~
28 ~~recording medium.~~

- 1 7. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 6, wherein said one or more substantially transparent elements
3 are selected from the group of substantially transparent elements consisting of
4 phase-altering, scattering, refracting, and diffracting.
- 1 8. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 6, wherein said step e) involves scanning said illumination
3 beam over said object mask and wherein said step f) involves simultaneously
4 scanning said reference beam over said holographic recording medium.
- 1 9. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 6, wherein said reference beam provided in said step f)
3 comprises a portion of said illumination beam.
- 1 10. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 6, wherein said step f) involves combining said reference
3 wavefronts and said object wavefronts with a beam combiner disposed between
4 said mask and said recording medium so as to make said reference wavefronts and
5 object wavefronts in-line.

- 1 11. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask for
2 ~~patterning a workpiece, formed by the process~~ comprising the steps of:
- 3 a) providing a substantially opaque object mask having a surface normal and
4 one or more substantially transparent elements for creating object
5 wavefronts when an illumination beam is incident thereon;
- 6 b) recording, in a first holographic recording medium disposed adjacent said
7 mask, a hologram capable of forming an in-focus real image at an in-focus
8 real image plane and a defocused real image at a defocused real image
9 plane;
- 10 c) disposing a second holographic recording medium in said defocused real
11 image plane;
- 12 d) illuminating said hologram so as to create said defocused real image;
- 13 e) providing a reference beam that interacts with said defocused real image
14 so as to create an interference pattern; and
- 15 f) recording said interference pattern in said second holographic recording
16 medium ~~so as to create a substantially continuous diffracting region over~~
17 ~~said holographic recording medium.~~
- 1 12. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 11, wherein said one or more substantially transparent
3 elements are selected from the group of substantially transparent elements
4 consisting of phase-altering, scattering, refracting, and diffracting.

1 13. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 11, wherein said step b) involves recording said hologram by
3 (i) illuminating said object mask with a first coherent illumination beam incident
4 said object mask at an angle with respect to said object mask surface normal and
5 (ii) simultaneously illuminating said first recording medium with a first reference
6 beam that is coherent with said first illumination beam and normally incident said
7 first recording medium.

1 14. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 11, wherein said step b) involves recording said hologram by
3 (i) illuminating said object mask with a first coherent illumination beam at normal
4 incidence with respect to said object mask surface normal, and (ii) simultaneously
5 illuminating said first recording medium with a first reference beam that is
6 coherent with said first illumination beam, at normal incidence to said first
7 recording medium.

1 15. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 11, wherein said step b) involves scanning an illumination
3 beam over said object mask while a reference beam is simultaneously scanned
4 over said first holographic recording medium.

- 1 16. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask for
2 ~~patterning a workpiece, formed by the process~~ comprising the steps of:
- 3 a) providing a substantially opaque object mask having one or more
4 substantially transparent elements for creating overlapping object
5 wavefronts when an illumination beam is incident thereon;
- 6 b) recording a hologram of said object mask as a first interference pattern in a
7 first holographic recording medium disposed adjacent said object mask;
- 8 c) removing said object mask and further recording in said first recording
9 medium a second interference pattern;
- 10 d) illuminating said hologram thereby creating (i) diffracted wavefronts
11 arising from diffraction by said first interference pattern in said hologram,
12 which form an in-focus real image at an in-focus image plane and (ii)
13 second reference wavefronts arising from diffraction by said second
14 interference pattern in said hologram which interacts with said diffracted
15 wavefronts so as to create a third interference pattern; and
- 16 e) recording said third interference pattern in a second holographic recording
17 medium disposed adjacent said hologram and in a defocused image plane
18 displaced from said in-focus image plane of said hologram as a
19 substantially continuous diffracting region over said holographic recording
 medium.

- 1 17. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 16, wherein said one or more substantially transparent
3 elements are selected from the group of substantially transparent elements
4 consisting of phase-altering, scattering, refracting, and diffracting.
- 1 18. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 16, wherein step b) involves using an illumination beam
3 normally incident on said object mask, and an off-axis first reference beam, and
4 step c) involves forming said second interference pattern using said first
5 illumination beam and said off-axis reference beam.
- 1 19. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask
2 according to claim 16, wherein said step b) said illumination beam is scanned over
3 said object mask while a reference beam is simultaneously scanned over said first
4 holographic recording medium.
- 1 20. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask as in
2 one of claims 2, 7, 12 or 17, wherein said one or more phase-altering elements are
3 indentations in said object mask.
- 1 21. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask as in
2 one of claims 2, 7, 12 or 17, wherein said one or more said phase-altering
3 elements are islands of transparent material.
- 1 22. (Currently Amended) A method of fabricating a ~~An in-line~~ holographic mask as in
2 one of claims 2, 7, 12 or 17, wherein said one or more scattering elements are
3 diffusers.

- 1 35. (Original) A method of patterning a workpiece comprising the steps of:
- 2 a) providing a source of illumination for generating a reconstruction beam
3 extending along an axis;
- 4 b) disposing on said axis a workpiece having a surface S;
- 5 c) providing a lens having an object plane and an image plane disposed
6 between said source of illumination and said workpiece such that said
7 image plane is proximate said surface S of said workpiece;
- 8 d) disposing an in-line holographic mask, capable of forming a real image,
9 between said source of illumination and said lens;
- 10 e) illuminating said in-line holographic mask with said source of illumination
11 and forming said real image at or near said lens object plane; and
- 12 f) transmitting said real image with said lens to a location at or near said
13 surface S of said workpiece.

- 1 36. (Original) A method of patterning a workpiece according to claim 35, wherein
2 said in-line holographic mask is that of claim 1, 2, 6, 7, 11, 12, 16 or 17.

Claims 37-44 (canceled)

- 1 45. (Original) An apparatus for patterning a workpiece, comprising:
- 2 a) a source of illumination;
- 3 b) a workpiece holder;
- 4 c) a lens having an object plane and an image plane, said lens disposed
5 between said source of illumination and said workpiece holder; and
- 6 d) an in-line holographic mask capable of forming a real image, said mask
7 being disposed between said source of illumination and said lens such that
8 said real image is formed at or near said object plane of said lens.
- 1 46. (Original) An apparatus for patterning a workpiece according to claim 45, wherein
2 said in-line holographic mask is one as in claim 1, 2, 6, 7, 11, 12, 16 or 17.
- 1 47. (Original) An apparatus according to claim 45, wherein said source of
2 illumination is capable of generating a reconstruction beam extending along an
3 axis and said workpiece holder and said mask are positioned on said axis.
- 1 48. (Original) A workpiece patterned using the method of patterning a workpiece as
2 set forth in claim 27.
49. (Canceled)

- 1 50. (New) A method of providing an image, comprising the steps of
- 2 a) providing a recording medium;
- 3 b) providing a mask in line with said recording medium, said mask
4 including a design having a first portion and a second portion,
5 wherein light traveling to said recording medium from said first
6 portion travels a different optical path length than light traveling to
7 said recording medium from said second portion, said mask
8 comprising a first side;
- 9 c) directing a first electromagnetic radiation exclusively on said first
10 side, wherein radiation originating from said first electromagnetic
11 radiation and emanating from said first portion interferes with
12 radiation originating from said first electromagnetic radiation and
13 emanating from said second portion because of said different
14 optical path length;
- 15 d) recording an interference pattern in said recording medium of said
16 interfering radiation originating from said first electromagnetic
17 radiation, wherein said recording of said interference pattern
18 includes a central area of said recording medium; and
- 19 e) directing a second electromagnetic radiation on said interference
20 pattern recorded in said recording medium to provide a real image,
21 wherein said real image includes contribution from said central
22 area.

- 1 51. (New) A method as recited in claim 50, wherein said first electromagnetic
2 radiation has a first wavelength and said second electromagnetic radiation has a
3 second wavelength different from said first wavelength.
- 1 52. (New) A method as recited in claim 50, wherein said first portion imparts upon
2 said electromagnetic radiation a phase or direction different from phase or
3 direction imparted to said electromagnetic radiation by said second portion.
- 1 53. (New) A method as recited in claim 50, wherein said second electromagnetic
2 radiation is transmitted through said recording medium
- 1 54. (New) A method as recited in claim 50, wherein said recording step (d) includes
2 recording said interference pattern in said recording medium without “clipping” or
“bottoming out” of the interference pattern.
- 1 55. (New) A method as recited in claim 54, wherein said recording step (d) includes
2 controlling exposure time, intensity of illumination, and developing procedure to
avoid said “clipping” or said “bottoming out.”
- 1 56. (New) A method as recited in claim 50, further comprising the step of transferring
2 said recording of said interference pattern to a durable substrate to provide a
3 durable holographic mask.

- 1 62. (New) A method as recited in claim 61, wherein said step of transferring from said
2 photoresist to said durable substrate comprises etching said durable substrate
3 using said photoresist as an etch mask.
- 1 63. (New) A method as recited in claim 62, wherein said etching comprises reactive
2 ion etching or ion milling said durable substrate.
- 1 64. (New) A method as recited in claim 58, wherein said recording medium is
2 photoresist or photopolymer, wherein said transferring step (b) further comprises
3 the step of transferring said recording from said photoresist or photopolymer to
4 said durable substrate.
- 1 65. (New) A method as recited in claim 64, wherein said step of transferring said
2 recording from said photoresist or photopolymer comprises etching said durable
3 substrate using said photoresist or photopolymer as an etch mask.
- 1 66. (New) A method as recited in claim 65, wherein said etching step comprises
2 reactive ion etching or ion milling said durable substrate.
- 1 67. (New) A method as recited in claim 57, wherein said transferring said recording
2 step (b) comprises etching said durable substrate.
- 1 68. (New) A method as recited in claim 67, wherein said etching comprises reactive
2 ion etching or ion milling said durable substrate.
- 1 69. (New) A method as recited in claim 57, wherein said durable substrate comprises
2 quartz, fused silica, calcium fluoride, lithium fluoride, germanium, silicon, zinc
3 selenide, zinc sulfide, Bk-7, diamond, mylar or beryllium.

- 1 70. (New) A method as recited in claim 1, wherein said recording step (f) includes
2 recording said interference pattern in said holographic recording medium without
“clipping” or “bottoming out” of the interference pattern.
- 1 71. (New) A method as recited in claim 70, wherein said recording step (f) includes
2 controlling exposure time, intensity of illumination, and developing procedure to
avoid said “clipping” or said “bottoming out.”
- 1 72. (New) A method as recited in claim 1, further comprising the step of transferring
2 said recording of said interference pattern to a durable substrate to provide a
3 durable holographic mask.
- 1 73. (New) A method as recited in claim 1, wherein in said providing step (b) said non
2 opaque object mask has a semi-transparent layer with an optical density between
3 0.1 and 5.0.
- 1 74. (New) A method as recited in claim 1, wherein in said illuminating step (e) said
2 reference wavefronts and said object wavefronts have a beam intensity ratio
3 between 0.1:1 and 100:1.
- 1 75. (New) A method as recited in claim 1, wherein said recoding step (f) involves
2 recording said interference pattern in said holographic recording medium so as to
3 create a substantially continuous diffracting region over said holographic
4 recording medium.
- 1 76. (New) A method as recited in claim 1, wherein said providing a non-opaque mask
2 step (b) comprises the step of photolithographically defining regions on a substrate
3 and etching said regions to provide indentations, islands, scattering elements,
4 lenslets, or grating elements for providing said substantially transparent elements.

- 1 77. (New) A method as recited in claim 6, wherein said recording step (g) includes
2 recording said interference pattern in said holographic recording medium without
“clipping” or “bottoming out” of the interference pattern.
- 1 78. (New) A method as recited in claim 73, wherein said recording step (g) includes
2 controlling exposure time, intensity of illumination, and developing procedure to
avoid said “clipping” or said “bottoming out.”
- 1 79. (New) A method as recited in claim 6, further comprising the step of transferring
2 said recording of said interference pattern to a durable substrate to provide a
3 durable holographic mask.
- 1 80. (New) A method as recited in claim 11, wherein said recording step (f) includes
2 recording said interference pattern in said holographic recording medium without
“clipping” or “bottoming out” of the interference pattern.
- 1 81. (New) A method as recited in claim 76, wherein said recording step (f) includes
2 controlling exposure time, intensity of illumination, and developing procedure to
avoid said “clipping” or said “bottoming out.”
- 1 82. (New) A method as recited in claim 11, further comprising the step of transferring
2 said recording of said interference pattern to a durable substrate to provide a
3 durable holographic mask.
- 1 83. (New) A method as recited in claim 16, wherein said recording step (e) includes
2 recording said interference pattern in said holographic recording medium without
“clipping” or “bottoming out” of the interference pattern.

- 1 84. (New) A method as recited in claim 79, wherein said recording step (e) includes
2 controlling exposure time, intensity of illumination, and developing procedure to
avoid said “clipping” or said “bottoming out.”
- 1 85. (New) A method as recited in claim 16, further comprising the step of transferring
2 said recording of said interference pattern to a durable substrate to provide a
3 durable holographic mask.
- 1 86. (New) A method as recited in claim 35, wherein in said disposing an in-line
2 holographic mask step (d) said in-line holographic mask comprises a holographic
3 recording formed in a durable substrate.
- 1 87. (New) A method as recited in claim 82, wherein said holographic recording in
2 said durable substrate is substantially without “clipping” or “bottoming out” of the
interference pattern.
- 1 88. (New) An apparatus as recited in claim 45, wherein said in-line holographic mask
2 comprises a holographic recording formed in a durable substrate.
- 1 89. (New) A method as recited in claim 84, wherein said holographic recording in
2 said durable substrate is substantially without “clipping” or “bottoming out” of the
interference pattern.